

## Space Technology for the Iron Foundry



**M**ore than three decades ago, NASA began developing spacecraft to carry man into space. Among the many challenging design requirements was a means of protecting astronauts returning to Earth from the searing heat of re-entry into the atmosphere. Designers came up with a heat shield in which part of the material was allowed to burn off, thus absorbing heat energy and protecting the rest of the spacecraft from friction heat. This type of shield was subsequently used in NASA's Mercury, Gemini and Apollo programs.

As an essential prelude and complement to flight testing of the shield, Langley Research Center—then man-in-space manager—planned an extensive series of ground tests. Because no adequate equipment existed to simulate re-entry temperatures, Langley contracted with Westinghouse Electric Corporation for development of a superheating system capable of subjecting heat shields to re-entry temperatures and even greater heat for safety margin.

Westinghouse responded with an electric torch in which a gas—such as nitrogen or air—is ionized by a high voltage power supply. The ionized gas, or plasma, superheats incoming gas and the gas exits the torch at high velocity and at temperatures as high as 10,000 degrees Fahrenheit.

After its use by NASA, the technology was not used extensively for a quarter century until 1983 when the Electric Power Research Institute (EPRI) initiated development of a plasma melter intended to solve a major problem in the U.S. foundry industry. Based in Palo Alto, California, EPRI is a non-profit organization that manages research and development for some 600 electric utility member companies. For the plasma melter program, EPRI enlisted as co-sponsors Westinghouse Electric's Environmental Systems and Services Division, Pittsburgh, Pennsylvania; General Motors Corporation's Central Foundry Division, Saginaw, Michigan; and Modern Equipment Company, Fort Washington, Wisconsin,

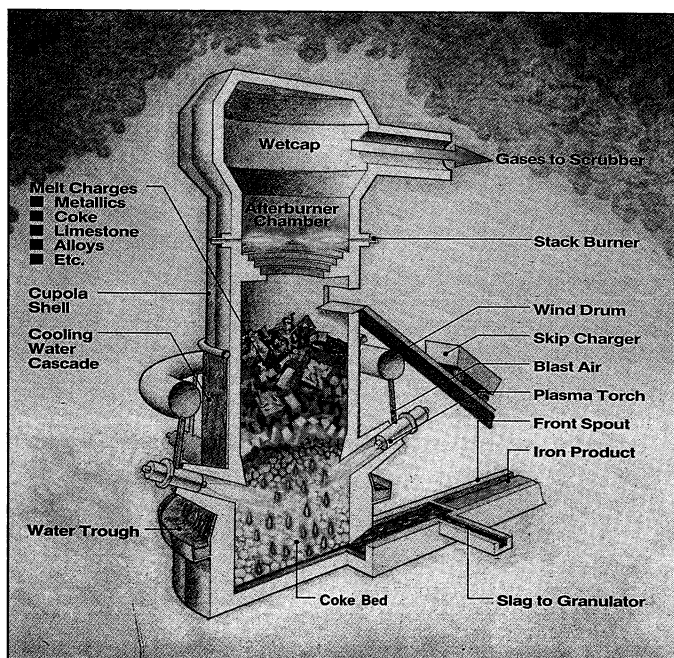
supplier of equipment and services to the foundry industry.

The problem was this: international competition and environmental constraints threatened the survival of U.S. foundries employing coke-burning cupolas, or melting furnaces, used to melt metal for castings. Foundries sought to reduce operating costs by using scrap iron as "charge" material, or feedstock, in place of expensive pig iron—but use of scrap materials in a conventional cupola can cause operating and metal chemistry problems. Additionally, use of cheaper high-sulphur fuels to cut costs was restricted by environmental regulations. Mounting operating costs and ever increasing international competition caused the number of U.S. foundry cupolas to drop from 3,000 in the 1950s to fewer than 850 in the late 1980s.

Seeking to make cupola operation more efficient and more competitive, the development team designed a plasma melter, using the decades-old plasma torch technology as the primary heat source, and built a pilot-scale test cupola at a Westinghouse facility near Pittsburgh. A three-year pilot program demonstrated conclusively that plasma melters can effectively melt scrap iron and thereby lower operating costs. General Motors then rebuilt a cupola at its Defiance (Ohio) foundry to incorporate six Westinghouse plasma torches in the cupola base where incoming air is directed to the combustion area to burn the coke. A portion of the incoming air is superheated by the torches, thus reducing the combustion energy required from coke. It also reduces the air volume needed in the cupola and that is the feature that allows operators to use lower-cost scrap iron as feedstock. The system offers an environmental bonus in reduced cupola emissions. In mid-1989, after a stringent three-month test program, the new melter was accepted for on-line casting production.

The plasma torches increase GM's electric bill at Defiance, but that cost is more than compensated by the savings in charge material, the major item of operating cost. For the Defiance

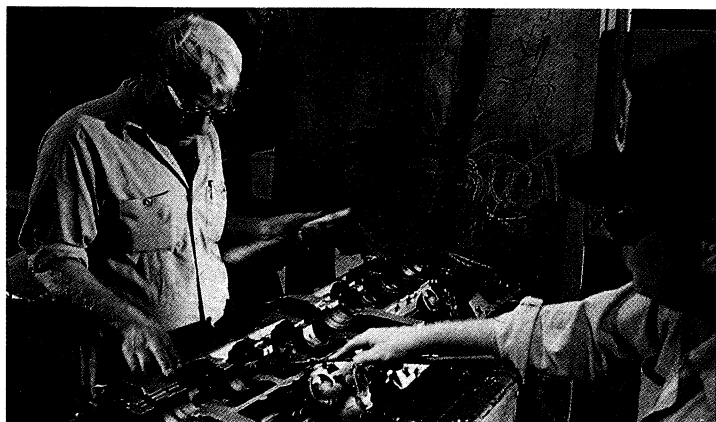
*A melting torch for more efficient foundry operation  
exemplifies spinoffs in industrial productivity  
and manufacturing technology*



*Shown in cutaway view is General Motor's plasma melter, first in the U.S., at the company's Defiance (Ohio) foundry. It is an advanced technology system designed to improve the efficiency of coke-burning cupolas that melt iron to produce automotive castings. The key elements are six Westinghouse plasma torches (two visible in lower cutaway).*



*The electrically-powered plasma torch creates an ionized gas that superheats air entering the cupola to 10,000 degrees Fahrenheit. That great heat, three times higher than that attainable by oil or natural gas systems, is the key to making iron cheaper, cleaner and faster.*



*Employees at the Defiance foundry inspect castings manufactured from iron melted in the plasma melter. The Defiance plant annually produces 400,000 tons of castings for GM cars and trucks.*

project, Toledo Edison—the local electric utility—worked closely with GM to develop an incentive package that further enhances the economic benefit of the plasma melter.

On the basis of early operation, Michael Hamilton, manager of the Defiance foundry that annually manufactures 400,000 tons of automotive castings for GM cars and trucks, feels that the spinoff technology has substantially brightened the facility's future in an increasingly competitive world marketplace. "Clearly," he says, "the plasma melter is producing the desired results."

If long term experience confirms the advantages, the whole U.S. foundry industry stands to benefit. And the potential benefit may extend beyond iron casting manufacture. The EPRI-sponsored Center for Materials Production (CMP), located at Carnegie Mellon University in Pittsburgh, serves as a project office to encourage broader application of the plasma melter. In a project jointly funded by EPRI and Westinghouse, CMP is evaluating the potential of plasma cupola technology for economical, large-scale recovery of usable iron from waste products generated by the steel industry.